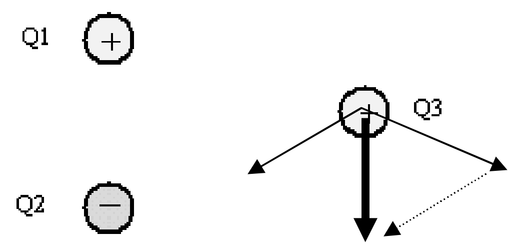
Exam Review Solutions

QUESTION 1
Three charges of equal magnitude are positioned as shown, with Q3 equidistant from Q1 and Q2. Q1 and Q3 are positive charges; Q2 is negative. What direction is the force on charge Q3?

- ☐ (a) left
- ☐ (b) right
- ☐ (c) up
- ☑ (d) down
- ☐ (e) the force is zero



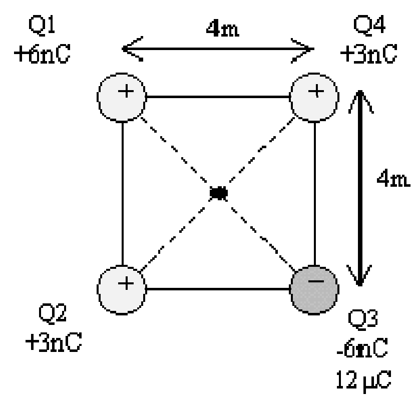
Via vector addition and symmetry, the net force on Q3 is down.

Question 2
This and the following three questions concern the same physical situation.

Four charges are fixed at the corners of a square of sides 4 m as shown.

What is the electric potential at the center of the square?

- ☐ (a) - 46.63 N-m/C
- ☐ (b) - 19.1 N-m/C
- ☐ (c) 0 N-m/C
- ☑ (d) + 19.1 N-m/C
- ☐ (e) + 46.3 N-m/C



$$V_{tot} = V_1 + V_2 + V_3 + V_4$$
$$= \frac{kq_1}{r} + \frac{kq_2}{r} + \frac{kq_3}{r} + \frac{kq_4}{r}$$
$$= \frac{k}{r}\left(q_1 + q_2 + q_3 + q_4\right)$$
$$= \frac{\left(9.0\times10^{9}\ \frac{N\bullet m^2}{C^2}\right)}{2\sqrt{2}m}\left(6\times10^{-9}C + 3\times10^{-9}C - 6\times10^{-9}C + 3\times10^{-9}C\right)$$
$$= 19.09\frac{N\cdot m}{C}$$

QUESTION 3
What is the magnitude of the electric field at the center of the square?

- [ ] (a) 7.0 N/C
- [x] (b) 13.5 N/C
- [ ] (c) 18.7 N/C
- [ ] (d) 27.5 N/C
- [ ] (e) 42.0 N/C

Q4 and Q2 cancel each other out by symmetry (look for symmetry)

Therefore
$$
\begin{aligned}
\varepsilon_{tot} &= \varepsilon_1 + \varepsilon_3 \\
&= \frac{kq_1}{r^2} + \frac{kq_3}{r^2} \\
&= \frac{k}{r^2}\left(q_1 + q_3\right) \\
&= \frac{9\times10^9}{8}\left(6\times10^{-9} + 6\times10^{-9}\right) \\
&= 13.5
\end{aligned}
$$

QUESTION 4
What is the direction of the force on charge Q1 due to charges Q2, Q3, and Q4 ?

- ( ) (a) along the vertical
- ( ) (b) along the horizontal
- (•) (c) along the diagonal

Q1 and Q4 combine to push away along the diagonal, while Q3 pull back along the diagonal

QUESTION 5

What is the magnitude of the force on charge Q1 due to charges Q2, Q3, and Q4 ?

- [x] (a) 0.42×10^{-8} N
- [ ] (b) 0.59×10^{-8} N
- [ ] (c) 1.19×10^{-8} N
- [ ] (d) 1.93×10^{-8} N
- [ ] (e) 2.45×10^{-8} N

$$F_{21} = \frac{kq_1q_2}{r^2}$$

$$= \frac{\left(9.0 \times 10^9 \frac{N \cdot m^2}{C^2}\right)\left(6\times10^{-9}C\right)\left(3\times10^{-9}C\right)}{\left(4m\right)^2}$$

$$= 1.0125\times10^{-8}N$$

This force is up

$$F_{41} = \frac{kq_1q_2}{r^2}$$

$$= \frac{\left(9.0 \times 10^9 \frac{N \cdot m^2}{C^2}\right)\left(6\times10^{-9}C\right)\left(3\times10^{-9}C\right)}{\left(4m\right)^2}$$

$$= 1.0125\times10^{-8}N$$

This force is to the left

Combining these forces $F = \sqrt{\left(1.0125\times10^{-8}N\right)^2 + \left(1.0125\times10^{-8}N\right)^2}$

$$= 1.432\times10^{-8}N$$

This force is upper right

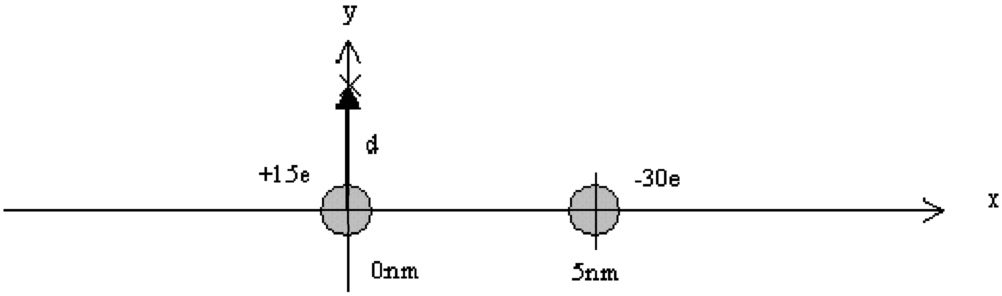
Now subtract $F_{31} = \frac{\left(9.0\times10^9 \frac{N \cdot m^2}{C^2}\right)\left(6\times10^{-9}C\right)\left(6\times10^{-9}C\right)}{\left(\sqrt{32}m\right)^2}$

$$= 1.0125\times10^{-8}N$$

This gives us $4.2\times10^{-9}N$

QUESTION 6
This and the following two questions concern the same physical situation.

A small particle with charge +15e (e = 1.6×10^{-19} C) is located at the origin, a distance of 5 nm from a second particle of charge –30e.



What is the potential energy of the two-charge system?

- ☐ (a) -6.90×10^{-9} J
- ☐ (b) -8.98×10^{-12} J
- ☐ (c) -3.33×10^{-15} J
- ☑ (d) -2.07×10^{-17} J
- ☐ (e) -4.15×10^{-19} J

$$U_E = \frac{kq_1q_2}{r}$$

$$= \frac{\left(9.0\times10^{9}\ \frac{N\cdot m^2}{C^2}\right)\left(15\cdot 1.6\times10^{-19}C\right)\left(-30\cdot 1.6\times10^{-19}C\right)}{5\times10^{-9}m}$$

$$= -2.07\times10^{-17}\,J$$

QUESTION 7
At what distance from the +15e particle along the x-axis is the electric potential equal to zero?

☐ (a) - 2.50 nm
☐ (b) 2.89 nm
☐ (c) 3.71 nm
☐ (d) 7.35 nm
☑ (e) - 5.00 nm

$$0 = V_1 + V_2$$

$$0 = \frac{kq_1}{r_x} + \frac{kq_2}{\left(5\times10^{-9}m - r_x\right)}$$

$$= \frac{\left(9.0\times10^{9}\,\frac{N\cdot m^2}{C^2}\right)\left(15\cdot1.6\times10^{-19}\,C\right)}{r_x} + \frac{\left(9.0\times10^{9}\,\frac{N\cdot m^2}{C^2}\right)\left(-30\cdot1.6\times10^{-19}\,C\right)}{5\times10^{-9}\,m - r_x}$$

$$\frac{\left(-30\cdot1.6\times10^{-19}C\right)}{5\times10^{-9}m - r_x} = \frac{\left(15\cdot1.6\times10^{-19}C\right)}{r_x}$$

$$\left(-30\cdot1.6\times10^{-19}C\right)r_x = \left(15\cdot1.6\times10^{-19}C\right)\left(5\times10^{-9}m\right) - \left(15\cdot1.6\times10^{-19}C\right)r_x$$

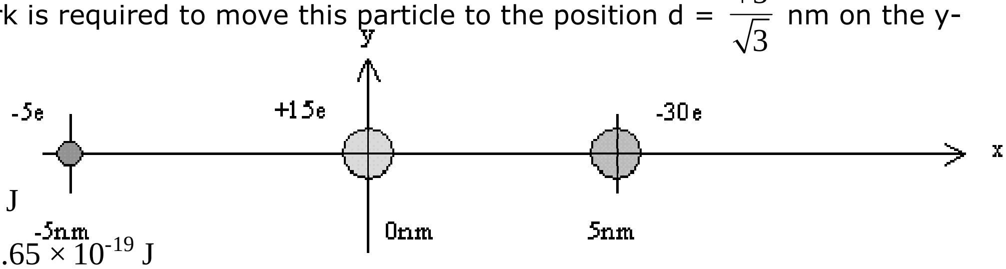
$$\left(-30\cdot1.6\times10^{-19}C\right)r_x + \left(15\cdot1.6\times10^{-19}C\right)r_x = \left(15\cdot1.6\times10^{-19}C\right)\left(5\times10^{-9}m\right)$$

$$r_x = \frac{\left(15\cdot1.6\times10^{-19}C\right)\left(5\times10^{-9}m\right)}{\left(-30\cdot1.6\times10^{-19}C\right) + \left(15\cdot1.6\times10^{-19}C\right)}$$

$$= -5\times10^{-9}\,m$$

QUESTION 8

A third particle of charge –5e is placed on the x-axis at the location –5 nm. How much work is required to move this particle to the position d = $\frac{+5}{\sqrt{3}}$ nm on the y-axis?



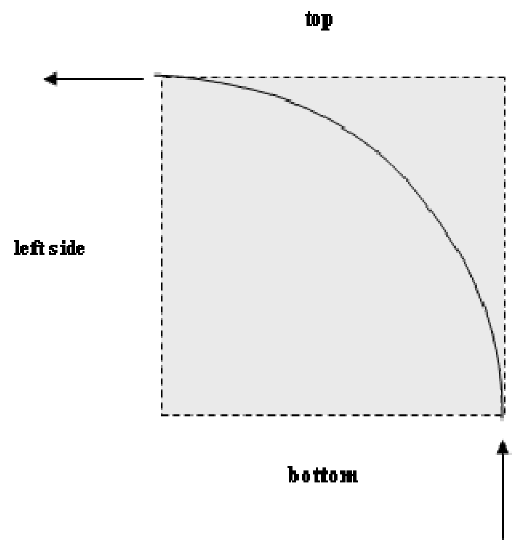
- [x] (a) 0 J
- [ ] (b) 6.65×10^{-19} J
- [ ] (c) 9.56×10^{-19} J
- [ ] (d) 1.24×10^{-18} J
- [ ] (e) 5.18×10^{-18} J

$$\begin{aligned} W &= F_E \cdot r \\ &= 0 \end{aligned}$$

Since ε and r are perpendicular, there is no work.

QUESTION 9

This and the next two questions pertain to the following situation.



The diagram shows a positive charge q entering the lower right hand corner of a region in which there is a uniform magnetic field. The field is perpendicular to the page. The particle emerges from the upper left hand corner of the region, moving directly leftward. Ignore gravity. Assume the strength of the field is B = 0.25 T and that the positive charge moves at v =6000 m/s. Does the field point **into** or **out of** the page?

- ( ) (a) into the page
- ( ) (b) out of the page

Right hand rule

QUESTION 10
Assuming still that a positive charge enters, as shown, in the lower right hand corner of the region, what change might cause the particle to exit through the bottom side, directly to the left of where it entered?

- (a) larger charge
- (b) greater velocity

From $\frac{e}{m} = \frac{v}{Br}$

$$r = \frac{mv}{Be}$$

It will take a large charge to make r larger, or a smaller velocity.

QUESTION 11
If the charge is a proton (q = 1.6 x 10^{-19}C, m = 1.673 x 10^{-27} kg), what is the area of the shaded region?

- (a) 2.3×10^{-8} m^2
- (b) 3.3×10^{-8} m^2
- (c) 4.3×10^{-8} m^2
- (d) 5.3×10^{-8} m^2
- (e) 6.3×10^{-8} m^2

$$r = \frac{mv}{qB}$$

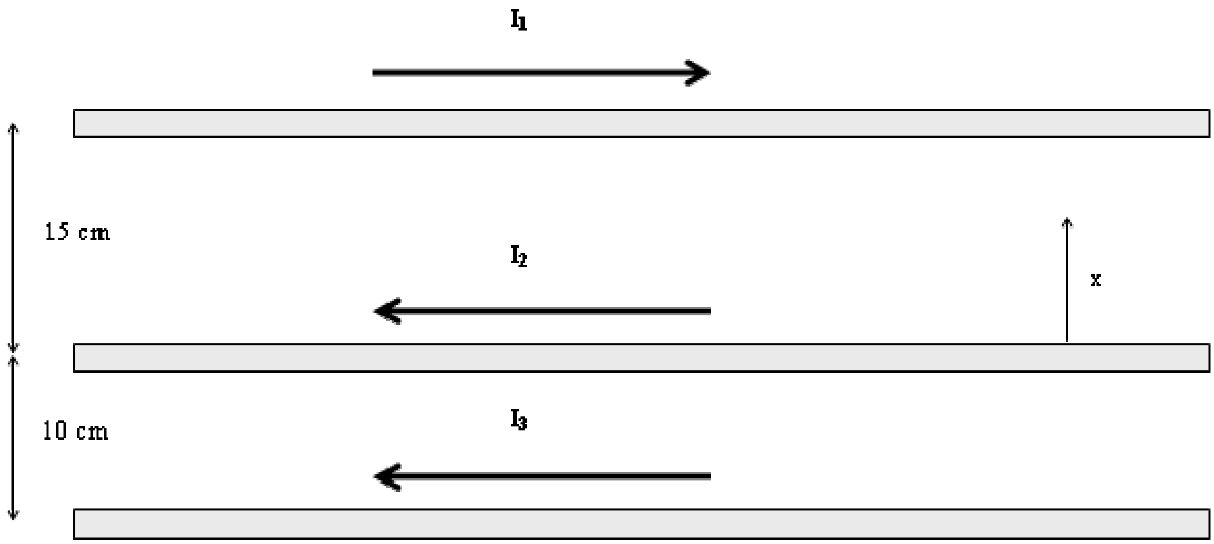
$$= \frac{\left(1.673\times10^{-27} kg\right)\left(6000\frac{m}{s}\right)}{\left(1.6\times10^{-19} C\right)\left(0.25T\right)}$$

$$= 2.5095\times10^{-4}$$

The area of the square is $6.3\times10^{-8} m^2$

QUESTION 12

This and the next question pertain to the following situation.



The diagram shows three wires, the first 15 cm directly above the second, and the second 10 cm directly above the third. The top wire carries current I_1 = 4 A to the right, the second carries I_2 = 2 A to the left.

Assuming **for this question only** that I_3 = 0, where between the first and second wires is the magnetic field zero?

- (a) x = 3 cm above the second wire
- (b) x = 5 cm above the second wire
- (c) There is no such point.

via the right hand rule, the magnetic direction in both wire 1 and wire 2 are in the same direction, they cannot cancel each other out.

QUESTION 13

Assume that the third wire carries I_3 = 3 A to the left. What are the magnitude and direction of the force exerted by the other two wires on a 20 cm length of the third wire?

- (a) 4.8×10^{-7} N upward
- (b) 4.32×10^{-7} N upward
- (c) 0
- (d) 4.32×10^{-7} N downward
- (e) 4.8×10^{-7} N downward

$$\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$F_1 = \frac{\left(4\pi \times 10^{-7} \frac{T \cdot m}{A}\right)(3A)(2A)}{2\pi\,(0.1m)} \times .2m$$

$$= 2.4 \times 10^{-6} N$$

$$F_2 = \frac{\left(4\pi \times 10^{-7} \frac{T \cdot m}{A}\right)(3A)(4A)}{2\pi\,(0.25m)} \times .2m$$

$$= 1.92 \times 10^{-6} N$$

$$F_1 - F_2 = 2.4 \times 10^{-6} N - 1.92 \times 10^{-6} N$$

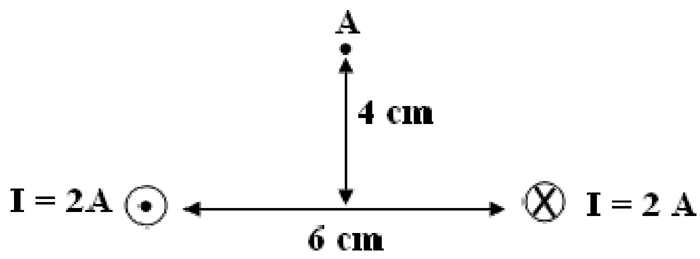
$$= 4.8 \times 10^{-7} N[up]$$

QUESTION 14
This and the next two questions pertain to the following situation.

Two wires perpendicular to the page are separated by 6 cm. The wire on the left carries a 2 A current out of the page; the wire on the right carries a 2 A current into the page. Point A, as shown, lies 4 cm above a point midway between the two wires.

What is the strength of the magnetic field at a point on the page midway between the two wires?

- ☐ (a) 0
- ☐ (b) 1.3×10^{-7} T
- ☐ (c) 2.7×10^{-7} T
- ☐ (d) 1.3×10^{-5} T
- ☑ (e) 2.7×10^{-5} T



The magnetic fields from each wire point in the same direction

Therefore each produces the following strength

$$B = \frac{u_0 I}{2\pi r} = \frac{\left(4\pi \times 10^{-7} \frac{T \cdot m}{A}\right)(2A)}{(2\pi)\left(3\times 10^{-2} m\right)} = 1.33\times 10^{-5} T$$

Therefore the total strength is $2\left(1.33\times 10^{-5} T\right) = 2.7\times 10^{-5} T$

QUESTION 15
An electron is fired into the page at point A. In what direction is the force acting on that electron at point A?

- ☐ (a) upward on the page
- ☐ (b) downward on the page
- ☐ (c) to the right on the page
- ☑ (d) to the left on the page
- ☐ (e) any force it experiences is perpendicular to the page

Right hand rule

QUESTION 16
Calculate the magnitude and direction of the force exerted on a 6 cm segment of the wire on the right by the wire on the left.

☐ (a) 7.5×10^{-6} N, to the left
☐ (b) 8.0×10^{-7} N, to the left
☐ (c) 0
☑ (d) 8.0×10^{-7} N, to the right
☐ (e) 7.5×10^{-6} N, to the right

$$F = \frac{\mu_0 I_1 I_2 l}{2\pi d}$$
$$= \frac{\left(4\pi \times 10^{-7}\,\frac{T \cdot m}{A}\right)(2A)(2A)\left(6\times 10^{-2}\,m\right)}{2\pi\left(6\times 10^{-2}\,m\right)}$$
$$= 8\times 10^{-7}\,N$$

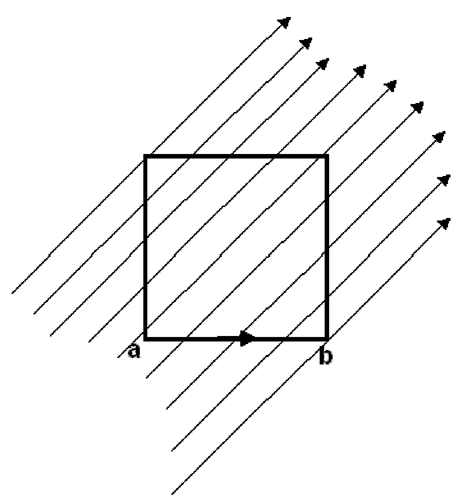
Since current is in opposite direction, the force is repulsive, therefore to the right

QUESTION 17
This and the next question are about the following situation:

In the figure is shown a **square** loop carrying a current of 2.5 A in a uniform B field of .02 T. The B-field makes an angle of 45° with the sides of the loop. The length of a loop side is .03 m.

What is $|F_{ab}|$ the magnitude of the magnetic force on side **ab**?

☐ (a) $|F_{ab}| = 0$ N
☐ (b) $|F_{ab}| = 3.6 \times 10^{-4}$ N
☑ (c) $|F_{ab}| = 10.6 \times 10^{-4}$ N
☐ (d) $|F_{ab}| = 15.0 \times 10^{-4}$ N
☐ (e) $|F_{ab}| = 18.4 \times 10^{-4}$ N



$$F = IlB\sin(\theta)$$
$$= (2.5A)(0.03m)(0.02T)\sin(45°)$$
$$= 10.6\times 10^{-4}\,N$$

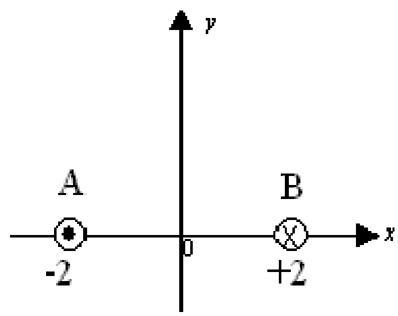
QUESTION 18
The direction of the force on side **ab** is

- (a) out of the page.
- (b) into the page.

Via right hand rule, out of the page

QUESTION 19
This and the next two questions are about the following situation:

The wires are located at (-2,0) meters and (2,0) meters. The former carries 3 A coming out from the sheet of the paper, and the latter 3 A going into it.



What is B_y, the y component of the magnetic field at the origin?

- (a) $B_y = -6 \times 10^{-7}$ T
- (b) $B_y = -3 \times 10^{-7}$ T
- (c) $B_y = 0$ T
- (d) $B_y = +3 \times 10^{-7}$ T
- (e) $B_y = +6 \times 10^{-7}$ T

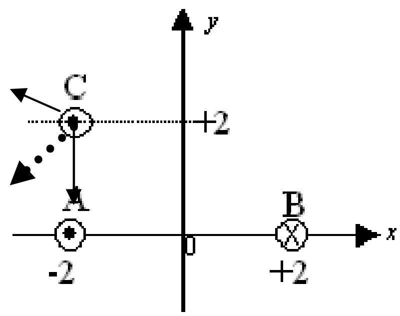
Each wire produces a magnetic field same T

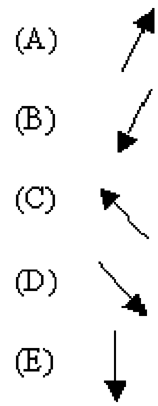
$$B = \frac{u_0 I}{2\pi r}$$
$$= \frac{\left(4\pi \times 10^{-7} \frac{T \cdot m}{A}\right)(3A)}{(2\pi)(2m)}$$
$$= 3.0 \times 10^{-7} T$$

Therefore $B_y = (2)\left(3 \times 10^{-7} T\right) = 6 \times 10^{-7} T$

QUESTION 20
Now a third wire C, carrying 3 A coming out of the page is placed at location (-2,2) meters. Which arrow of those shown at the far right best represents the direction of the <u>force</u> on C due to the currents in wires A and B?

- [ ] (a)
- [x] (b)
- [ ] (c)
- [ ] (d)
- [ ] (e)



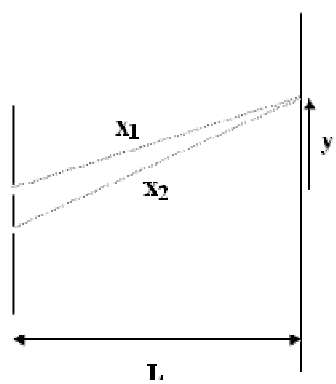


From right hand rule

QUESTION 21
This and the next three questions are about the following situation:

Monochromatic light (of wavelength λ = 480 nm) is incident on two slits separated by an unknown distance d. Bright fringes are observed on a screen at a distance L = 1.5 m from the two slits. Note that **y** in the diagram represents a distance along the screen as measured from the center of the central bright fringe (for which therefore y = 0). The variables x_1 and x_2 label the distances from the respective slits to points on the screen. The fifth bright fringe to one side of the central fringe is observed to be at y = 1.8 cm. Find the slit separation d.

- [x] (a) $d = 2.0 \times 10^{-4}$ m
- [ ] (b) $d = 2.5 \times 10^{-4}$ m
- [ ] (c) $d = 4.0 \times 10^{-4}$ m
- [ ] (d) $d = 8.0 \times 10^{-4}$ m
- [ ] (e) $d = 1.0 \times 10^{-3}$ m



$$\Delta x = \frac{1.8\times10^{-2}}{5} = 3.6\times10^{3} m$$

$$\frac{\Delta x}{L} = \frac{\lambda}{d}$$

$$d = \frac{\lambda L}{\Delta x} = \frac{(4.8\times10^{-7} m)(1.5)}{3.6\times10^{3} m} = 2\times10^{-4} m$$

or

$$\frac{m\lambda}{d} = \frac{x_5}{L}$$

$$d = \frac{m\lambda L}{x_5} = \frac{(5)(4.8\times10^{-7} m)(1.5m)}{1.8\times10^{-2} m} = 2\times10^{-4} m$$

QUESTION 22
Find, from among the following choices, the location y on the screen closest to the point at which the quantity $x_2 - x_1 = 1440$ nm.

- ○ (a) y = 0.5 cm
- ○ (b) y = 0.8 cm
- ● (c) y = 1.1 cm

Determine how many wavelengths the path difference between x_1 and x_2 represents

$$\frac{1.44\times10^{-6}m}{4.8\times10^{-7}m}=3$$

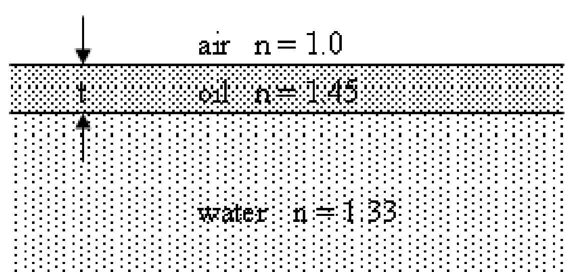
Therefore
$$\frac{m\lambda}{d}=\frac{x_3}{L}$$
$$\frac{3\left(4.8\times10^{-7}m\right)}{2.0\times10^{-4}m}=\frac{x_3}{1.5m}$$
$$x_3=1.08\times10^{-2}m$$

QUESTION 23
This and the next question are about the following situation:

A film of oil of thickness t is floating on water. The index of refraction is 1.0, 1.45, and 1.33 for air, oil, and water, respectively. A person views the film from the air in a direction normal to the surface.

The person sees that there is constructive interference of reflected light of wavelength 630 nm. What is the minimum thickness t of the oil film?

- ● (a) 109 nm
- ○ (b) 218 nm
- ○ (c) 436 nm



when the light reflects off the oil it causes a $\frac{\lambda}{2}$ phase shift since $n_{air} < n_{oil}$

When the ray passes through the oil and reflects of the water, no phase shift occurs since $n_{oil} > n_{water}$.

The wavelength of the ray in the oil is $\lambda_{oil} = \frac{\lambda_{air}}{n_{oil}} = \frac{6.3\times10^{-7}m}{1.45} = 4.34\times10^{-7}m$

For constructive interference to occur, $2t = \frac{m}{2}\lambda$

$$4t = m\lambda$$
$$4t = (1)(4.34\times10^{-7}m)$$
$$t = \frac{4.34\times10^{-7}m}{4}$$
$$= 1.085\times10^{-7}m$$

QUESTION 24

The person sees that there is destructive interference of reflected light of wavelength 450 nm. What is the minimum thickness t of the oil film?

- (a) 155 nm
- (b) 225 nm
- (c) 310 nm

when the light reflects off the oil it causes a $\frac{\lambda}{2}$ phase shift since $n_{air} < n_{oil}$

When the ray passes through the oil and reflects of the water, no phase shift occurs since $n_{oil} > n_{water}$.

The wavelength of the ray in the oil is $\lambda_{oil} = \frac{\lambda_{air}}{n_{oil}} = \frac{4.5\times10^{-7}m}{1.45} = 3.10\times10^{-7}m$

For destructive interference to occur, $2t = m\lambda$

$$2t = m\lambda$$
$$2t = (1)(3.10\times10^{-7}m)$$
$$t = \frac{3.10\times10^{-7}m}{2}$$
$$= 1.55\times10^{-7}m$$

QUESTION 25
This and the next question are about the following situation:

For a wavelength of 440 nm, a diffraction grating produces a 2nd-order bright fringe at an angle of 28°.

What is the slit spacing of the grating?

- ○ (a) 937 nm
- ◉ (b) 1,870 nm
- ○ (c) 3,749 nm

$$m\lambda = d\sin(\theta_m)$$

$$d = \frac{m\lambda}{\sin(\theta_m)}$$

$$= \frac{(2)(4.40\times10^{-7}m)}{\sin(28°)}$$

$$= 1.87\times10^{-6}m$$

QUESTION 26
For an unknown wavelength, the same grating produces a 2nd-order bright fringe at an angle of 42°. What is the unknown wavelength?

- ○ (a) 308 nm
- ○ (b) 314 nm
- ◉ (c) 626 nm

$$m\lambda = d\sin(\theta_m)$$

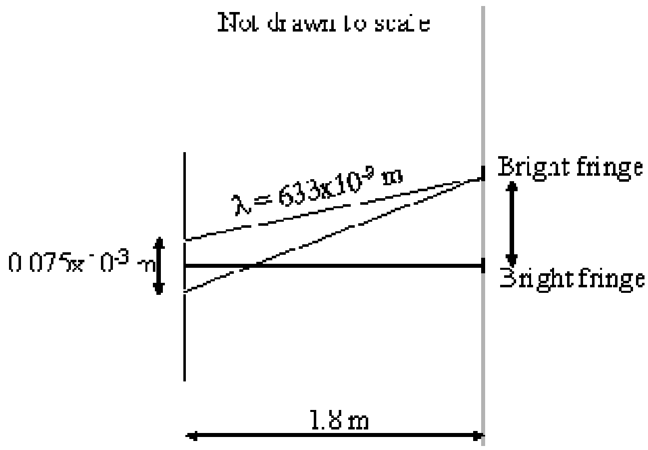
$$\lambda = \frac{d\sin(\theta_m)}{m}$$

$$= \frac{(1.87\times10^{-6}m)(\sin(42°))}{2}$$

$$= 6.26\times10^{-7}m$$

QUESTION 27
This and the next two questions are about the following situation:

A double-slit experiment is set up using red light with a wavelength of 633 nm. The slits are separated by a distance of 0.075 mm. The interference pattern is viewed on a screen 1.8 m away from the slits.



What is the distance between two adjacent bright fringes on the screen?

- (a) 1.52 cm
- (b) 1.69 cm
- (c) 3.04 cm

$$\Delta x = \frac{L\lambda}{d}$$
$$= \frac{(1.8m)(6.33\times10^{-7}m)}{7.5\times10^{-5}m}$$
$$= 1.52\times10^{-2}m$$

QUESTION 28
What is the distance between two adjacent dark fringes on the screen?

- (a) 0.76 cm
- (b) 1.52 cm
- (c) 1.69 cm

same as above in question 27

QUESTION 29
What is the difference in the distance traveled by the rays from the top and bottom slit reaching the third order bright fringe on the screen?

- (a) 633 nm
- (b) 950 nm
- (c) 1899 nm

$$m\lambda = \left|P_3S_1 - P_3S_2\right|$$
$$3\left(6.33\times10^{-7}\,m\right) = \left|P_3S_1 - P_3S_2\right|$$
$$\left|P_3S_1 - P_3S_2\right| = 1.899\times10^{-6}m$$

QUESTION 30
A single slit of width 0.075 mm, illuminated by light of wavelength 633 nm, yields a diffraction pattern on a screen 1.8 m away. What is the distance between the central bright fringe and the second order dark fringe on the screen?

- (a) 1.5 cm
- (b) 1.7 cm
- (c) 3.0 cm

$$m\lambda = \frac{wx_m}{L}$$
$$(2)\left(6.33\times10^{-7}\,m\right) = \frac{\left(7.5\times10^{-5}\,m\right)x_2}{1.8m}$$
$$x_2 = \frac{(2)\left(6.33\times10^{-7}\,m\right)(1.8m)}{\left(7.5\times10^{-5}\,m\right)}$$
$$= 3.04\times10^{-2}\,m$$

QUESTION 31
A spaceship passes you at a speed of 0.92c. You measure its length to be 48.2 m. How long World the slip be at rest?

$$L_m = L_s\sqrt{1-\frac{v^2}{c^2}}$$
$$48.2m = L_s\sqrt{1-\frac{(0.92c)^2}{c^2}}$$
$$L_s = \frac{48.2m}{\sqrt{1-(0.92)^2}}$$
$$=123m$$

QUESTION 32
An electron is traveling at 0.866c with respect to the face of a monitor. What is the value of its relativistic momentum with respect to the tube?

$$p = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}}$$
$$= \frac{(9.11\times10^{-31}kg)(0.866c)}{\sqrt{1-\frac{(0.866c)^2}{c^2}}}$$
$$=4.73\times10^{-22}\frac{kg\cdot m}{s}$$

QUESTION 33
The total energy of a certain muon, a particle with a rest energy of 105.7 MeV, is 106.7 MeV. What is its kinetic energy?

$$E_{total} = E_k + E_{rest}$$
$$\frac{mc^2}{\sqrt{1-\frac{v^2}{c^2}}} = E_k + mc^2$$
$$106.7MeV = E_k + 105.7MeV$$
$$E_k = 1MeV$$

QUESTION 34
Calculate the energy of an ultraviolet photon, of 122nm, in electron volts.

$$E = \frac{hc}{\lambda}$$
$$= \frac{\left(6.63\times10^{-34}\,J\cdot s\right)\left(3.00\times10^{8}\,\frac{m}{s}\right)}{1.22\times10^{-7}\,m}$$
$$= 1.63\times10^{-18}\,J$$

Now, $\dfrac{1.63\times10^{-18}\,J}{1.60\times10^{-19}\,\frac{J}{eV}} = 10.2eV$

QUESTION 35
When a certain metal is illuminated at $3.50\times10^{2}\,nm$, the maximum kinetic energy of the ejected electron is 1.20 eV. Calculate the work function of the metal.

$$E_k = E_{photon} - W$$
$$W = E_{photon} - E_k$$
$$= \frac{hc}{\lambda} - 1.20eV$$
$$= \frac{\left(6.63\times10^{-34}\,J\cdot s\right)\left(3.00\times10^{8}\,\frac{m}{s}\right)}{\left(3.50\times10^{-7}\,m\right)}\cdot\frac{1}{1.6\times10^{-19}\,\frac{J}{eV}} - 1.20eV$$
$$= 2.35eV$$

QUESTION 36
Light of frequency $8.0\times10^{14}\,Hz$ illuminates a surface whose work function is 12eV. If the retarding potential is 1.0V, what is the maximum speed with which an electron reaches the plate?

First we calculate the kinetic energy

$$E_k = E_{photon} - W$$
$$= hf - W$$
$$= \left(6.63\times10^{-34}\,J\cdot s\right)\left(8.0\times10^{14}\,Hz\right)\frac{1}{1.6\times10^{-19}\,\frac{J}{eV}} - 1.2eV$$
$$= 2.115eV$$

Now for maximum speed
Since we have a retarding potential of 1.0eV , then

$$2.115eV - 1.0eV = 1.115eV$$

This is the kinetic energy we must use. (don't forget to change back to Joules)

$$1.115eV \cdot 1.6\times10^{-19}\frac{J}{ev} = 1.784\times10^{-19}J$$

$$\begin{aligned} v &= \sqrt{\frac{2E_k}{m}} \\ &= \sqrt{\frac{2\left(1.784\times10^{-19}J\right)}{9.115\times10^{-31}kg}} \\ &= 6.3\times10^{5}\frac{m}{s} \end{aligned}$$

QUESTION 37
What is the magnitude of the momentum of a photon with a wavelength of $1.3\times10^{-12}m$?

$$\begin{aligned} p &= \frac{h}{\lambda} \\ &= \frac{6.63\times10^{-34}J\cdot s}{1.3\times10^{-12}m} \\ &= 5.1\times10^{-22}\frac{kg\cdot m}{s} \end{aligned}$$

QUESTION 38
What is the de Broglie wavelength associated with a 1 kg ball moving at 20.1 m/s?

$$\begin{aligned} \lambda &= \frac{h}{mv} \\ &= \frac{6.63\times10^{-34}J\cdot s}{\left(1.0kg\right)\left(20.1\frac{m}{s}\right)} \\ &= 3.3\times10^{-35}m \end{aligned}$$

QUESTION 39
Calculate the energy of n=5 state for hydrogen, and state it with respect to the ground state.

$$E = -\frac{13.6eV}{n^2}$$
$$= -\frac{13.6}{5^2}$$
$$= -0.544eV$$

The n=5 energy level is -0.54 eV or -13.6eV-(-0.54eV)=13.06eV above ground state.

QUESTION 40
Give the value of x and y in the following: ${}^{212}_{x}Pb \rightarrow {}^{212}_{83}Bi + y$

X=82, y=${}^{0}_{-1}e$

QUESTION 41
Identify the missing particle, state whether the element has undergone α or β decay

a) ${}^{141}_{57}La \rightarrow {}^{141}_{58}Ce + ?$
b) ${}^{238}_{92}U \rightarrow {}^{234}_{90}Th + ?$

a) ${}^{0}_{-1}e$, β decay
b) ${}^{4}_{2}He$, α decay

QUESTION 42

The half life of unanium-238 is 4.5×10^{9} years. If you contain a sample of 1.00 mg of U-238 and determine that it has an activity of $3.8\times10^{8}Bq$.
How many years will pass before you have 0.100mg of the specimen left?

First , the $3.8\times10^{8}Bq$ activity has no bearing on this question

$$N = N_0\left(\frac{1}{2}\right)^{\frac{t}{half-life}}$$

$$0.100 = 1.00\left(\frac{1}{2}\right)^{\frac{t}{4.5\times10^{9}}}$$

$$\frac{0.100}{1.00} = \left(\frac{1}{2}\right)^{\frac{t}{4.5\times10^{9}}}$$

$$\log\left(\frac{0.100}{1.00}\right) = \log\left(\left(\frac{1}{2}\right)^{\frac{t}{4.5\times10^{9}}}\right)$$

$$\frac{t}{4.5\times10^{9}}\log\left(\frac{1}{2}\right) = \log\left(\frac{0.100}{1.00}\right)$$

$$t = \log\left(\frac{0.100}{1.00}\right)\frac{4.5\times10^{9}}{\log\left(\frac{1}{2}\right)}$$

$$= 1.5\times10^{10}$$

Hopefully you live that long.